

CONTROLLING THE CURCULIO, BROWN- ROT, AND SCAB IN THE PEACH BELT OF GEORGIA

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THE PEACH CROP OF 1921 SAVED FROM THE CURCULIO AND BROWN-ROT.

GEORGIA'S RECORD PEACH CROP of 1921 was remarkably free from curculio injury and from brown-rot. During that season almost twice as much merchantable fruit was shipped out of the State as during the preceding year, and at least \$10,000,000 was received for the crop. This rescued the peach industry in Georgia from partial collapse, as the almost complete failures experienced during the two preceding years had placed the peach belt in a very serious financial condition.

The success achieved in controlling the curculio and brown-rot, after the very heavy curculio infestation during previous years, which left vast numbers of beetles in the orchards to prey upon succeeding crops, was indeed phenomenal, and was due to the fact that the growers carried out a program of control measures recommended by the United States Bureau of Entomology, the Georgia State Board of Entomology, and the United States Bureau of Plant Industry. Favorable weather conditions also played a part in the successful control of these pests in 1921. During the two previous seasons rains pre-

¹ *Conotrachelus nenuphar* Hbst.; order Coleoptera, family Curculionidae.

² *Sclerotinia cinerea*.

³ *Cladosporium carpophilum*.

ceding and during peach harvest were frequent. The object of this circular is to present to the peach growers of Georgia and the South information concerning the various measures used in the successful control of the curculio, in order that they may be utilized in the future against the pest. The results of the spraying and dusting experiments conducted in the Georgia peach belt during the season of 1921 are given, along with the spraying and dusting schedules, for future use.

GROWTH OF THE PEACH INDUSTRY IN GEORGIA.

The culture of peaches in Georgia has increased very rapidly during the last decade, and the industry is now one of the most important in the State, the prosperity and financial welfare of a number of counties in middle Georgia being dependent, directly or indirectly, on the success of the peach crop. Reports of the Bureau of the Census show that in 1890 there were in Georgia 2,787,546 peach trees of bearing age; by 1900 the number had increased to 7,668,639, and by 1910 and 3,391,851 in 1920. The acreage devoted to peaches has been was not due to a decreased commercial peach acreage, but to the abandonment of many home orchards. In 1920, 4,788,718 bushels of merchantable peaches were produced in the State from commercial orchards, as compared with only 2,555,499 bushels in 1910.

The acreage of peach trees of nonbearing age in Georgia has increased over 100 per cent during the last 10 years. According to the Census reports there were 1,531,367 such trees in the State in 1910 and 3,391,851 in 1920. The acreage devoted to peaches has been greatly increased since the 1920 census figures were obtained and is still being increased. The severe damage to the Georgia cotton crop by the boll weevil and the recent exceedingly low price of cotton are largely responsible for this increase. Many large plantings of peach trees are now under way in sections of the State where peaches have never been grown commercially before (fig. 1).

LOSSES FROM THE CURCULIO AND BROWN-ROT.

The year 1920 will long be remembered by the Georgia grower as the "wormy-peach year." The losses to individual growers were tremendous, and an exceedingly low estimate of the damage by the curculio to the 1920 Georgia peach crop as a whole is placed at \$2,000,000. According to the Bureau of Markets and Crop Estimates of the United States Department of Agriculture, only 5,663 carloads of peaches were shipped from the State in 1920 in contrast with 10,559 carloads in 1921. Many more peaches were produced in Georgia in 1920, but they were rendered unmarketable by the curculio. The peach crop of 1919 was also a partial failure, owing to combined

injury by the curculio and brown-rot. The shipments for the season of 1919, as reported by the Bureau of Markets and Crop Estimates, were 7,236 carloads.

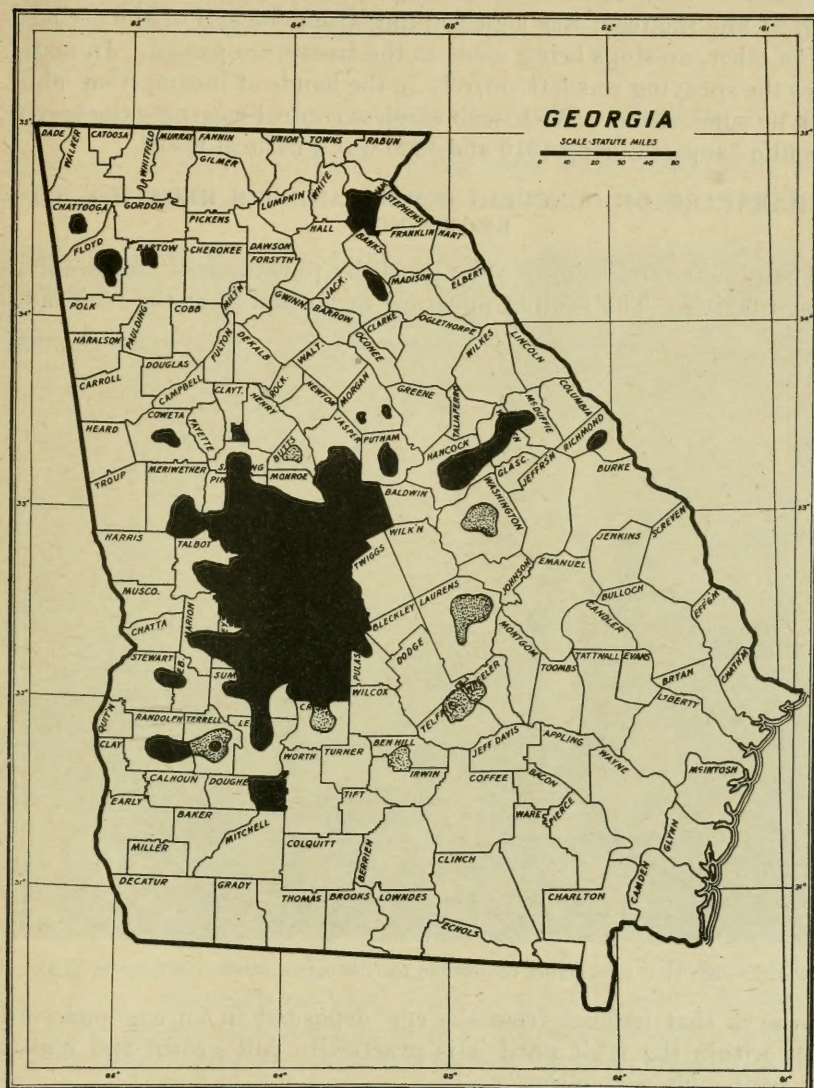


FIG. 1.—Outline map of Georgia showing, in solid black, old peach belt; in dotted areas, sections where new plantings are being made.

The great abundance of the curculio in Georgia during 1920 can be attributed directly to the careless and inefficient control measures practiced by the growers during preceding years. The progeny of a number of generations of the curculio, not satisfactorily controlled,

had been multiplying for several years. During these years some growers failed to spray, and the careless spraying of others was worthless. Very often the entire spraying crew rode on the tank (fig. 2) and the team was kept walking from one end of the orchard to the other, no stops being made as the trees were passed. In many cases the spraying was left entirely in the hands of incompetent labor with no supervision. With such careless control measures the severe curculio damage during 1919 and 1920 was a natural result.

CHARACTER OF CURCULIO INJURY AND ITS RELATION TO BROWN-ROT.

The plum curculio injures the peach by puncturing it for feeding or egg-laying. The feeding puncture very often scars the fruit, and



FIG. 2.—The kind of spraying responsible for the severe curculio damage in 1920.

the larva that hatches from the egg deposited in an egg puncture lives within the fruit until it is practically full grown and makes the fruit unfit for market.

The curculio not only damages the peach directly, but the rupture of the skin for feeding or oviposition furnishes a place for brown-rot to enter; in fact, a very large percentage of the brown-rot infections in the peach belt of Georgia are caused in this way. A heavy curculio infestation, therefore, facilitates the establishment of brown-rot infections.

A majority of the peaches that are punctured by the curculio soon after the fruit sets fall to the ground before the stone begins to

harden. After the fruit enters the stone-hardening period, which is the rapidly growing period of the fruit, there is little curculio activity and very few larvæ develop to maturity. As the fruit enters the ripening period, however, which is usually about four weeks before harvest, curculio activity is resumed, and the larvæ readily mature in the fruit.

ORCHARD SANITATION FOR CURCULIO CONTROL.

The curculio lives over winter in the adult stage, hibernating in grown-up fence or terrace rows in or near the orchard, or in near-by



FIG. 3.—Burning over woodlands to destroy hibernating curculios.

woodlands, waste fields, pruning piles, or rubbish. The burning over of any woodlands or waste land adjacent to peach orchards, therefore, undoubtedly destroys many of the adult beetles. Figures 3 and 4 show a strip of woodland beside a large commercial peach orchard being burned over during the clean-up campaign conducted in Georgia during the winter of 1920-21.

The curculio infestation in the Georgia peach belt in 1920 was probably the heaviest that has ever occurred in America. Myriads of adult curculios were left to hibernate the following winter. To control this vast army of overwintering beetles and save the next crop seemed a very difficult problem. It would probably have been

impossible to combat the insect successfully in Georgia in 1921 with spraying and dusting alone, owing to the extremely abnormal curculio conditions that existed in the State the year before. It was necessary to adopt other measures, and the burning and cleaning-up campaign waged by the growers during the winter without doubt reduced materially the number of curculios that made their appearance in the spring.

Not only should the adjoining woodlands and waste lands be burned over and the pruning, brush, and rubbish heaps be destroyed, but the vegetation that has grown up along fence rows should also



FIG. 4.—Woodlands near peach orchard thoroughly burned over to destroy hibernating curculios.

be grubbed out and destroyed (fig. 5). Terrace rows in and near the orchard (fig. 6) should receive some attention during the winter months, as both fence and terrace rows grown up to vegetation furnish excellent hibernating quarters for the curculio.

There are very few days during the winter months when this work can be properly done, as a sweeping, vigorous fire is necessary to burn the vegetation and rubbish close to the ground. For this work, therefore, orchardists should take advantage of the first dry period after the first killing frost in the fall. All undergrowth in woods or waste lands within 200 or 300 yards of orchards should be burned off, as the burning off of areas of the size thus covered will

be sufficient to destroy a majority of the insects hibernating in such places. Sufficient supervision and labor should be close at hand during the burning to handle the fire properly, and precaution should be taken to keep it from damaging telephone and telegraph poles, fences and fence posts, and all buildings.

It is not advisable to undertake any burning in the orchard, unless it is for the destruction of vegetation or rubbish on a terrace row or along a fence, in which case the proper steps should be taken to keep the fire from damaging any of the trees.



FIG. 5.—Cleaning up fence rows to destroy curculio hibernating quarters.

PICKING UP AND DESTROYING "DROPS."

A majority of the peaches punctured while small fall to the ground within a few weeks after the calyces, or "shucks," have been pushed off. The larvæ, however, remain in them and develop until, having reached maturity, they eat their way out of the fruit and enter the soil to transform to adults. Life-history studies conducted by Mr. E. R. Selkregg during the season of 1921 show two complete generations of the curculio in Georgia. The beetles that result from eggs deposited in the small peaches lay the eggs for the second generation. The "worms" in the Belle of Georgias and Elbertas in Georgia, and in some years those in the Hileys, are mostly second-generation larvæ.

The importance of picking up and destroying all fallen peaches, especially those that fall soon after the shedding of the "shucks," can therefore be readily seen. The size of the second generation, which is so injurious to the desirable late varieties, can be greatly reduced by the systematic destruction of fallen peaches throughout the season. This measure probably assisted more than any other in controlling the curculio in the 1921 Georgia peach crop; and peach growers in the South would be wise to make this practice, especially, a part of their annual program of orchard management.

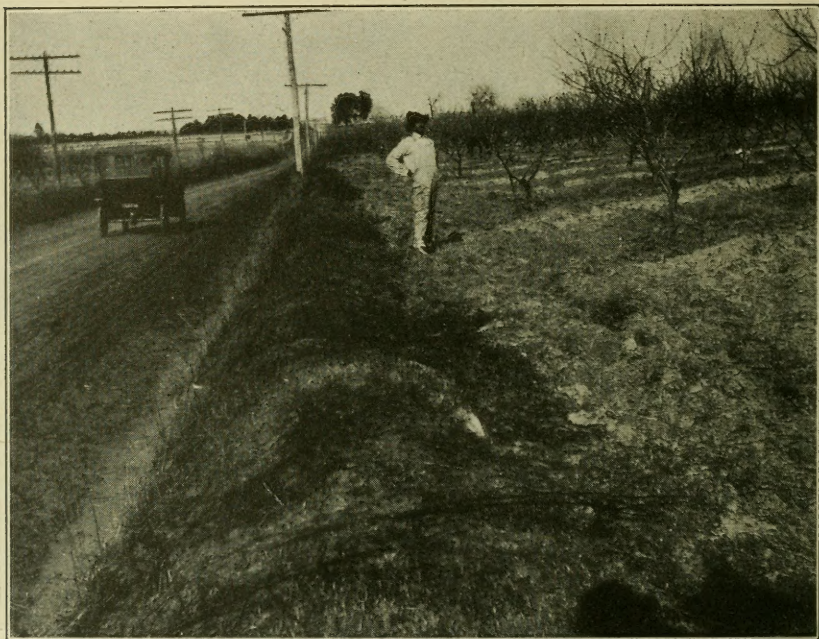


FIG. 6.—Clean terrace rows reduced hibernating quarters for the curculio. Note sanitation work in the orchard.

From 75 to 90 per cent of the small peaches that fall to the ground shortly after the fruit has set contain one or more larvæ, or "worms," of the curculio. An experiment conducted at the Peach Pest Laboratory at Fort Valley, Ga., gives some idea of the results that may be expected from the picking up and destruction of these small infested peaches. About $2\frac{1}{2}$ bushels of "drops" were picked up from under trees in the vicinity of Fort Valley soon after the pollination season. The fruit was kept in wire cylinders and daily observations were made as to the number of larvæ, or "worms," which, having reached maturity, left the fruit. Within a few weeks after this fruit was gathered more than 13,000 larvæ of the curculio had eaten their way out of the $2\frac{1}{2}$ bushels of "drops" to enter the soil, where

the pupa stage is passed. The adult curculios that ultimately would have resulted from those larvæ could have heavily infested a 100,000-tree orchard by harvest time.

It is especially important to pick up the smallest "drops," as these are nearly always infested. For this reason it is not advisable to pay for the work by the basket, as then an effort is made by the laborers to secure the large peaches in order to fill the baskets quickly, and many small ones are left. It is very seldom that a small, hard, leathery, and dried-up "drop" does not contain a larva

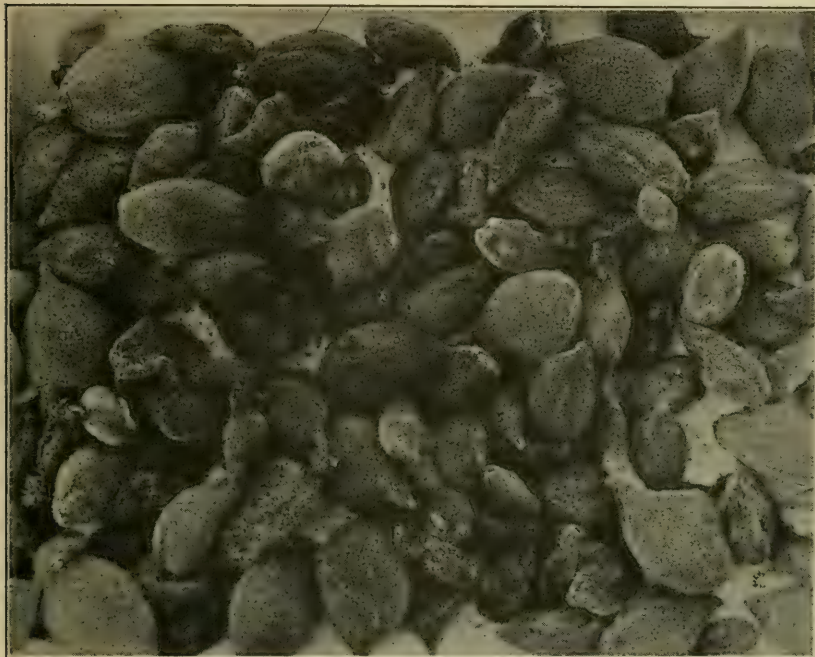


FIG. 7.—It is important to pick up these small, hard, dried-up "drops," as they are the ones usually infested with curculio larvæ.

of the curculio (fig. 7). The larger "drops" (fig. 8) are not so likely to contain the "worm."

Probably the best way to destroy these fallen peaches is by burying deeply with quicklime. They should be placed at least 24 inches below the soil surface. Growers have found a long trench that can be extended from time to time useful for the destruction of "drops." The "drops" should be covered with the soil after the quicklime has been added. It is very necessary to bury "drops" deeply, so that any beetles that might possibly emerge can not get out through the soil, as might be the case if the trench were shallow. Some growers have tried burning the "drops"; but this is not very satis-

factory, as many peaches on the outside of the pile are not burned, and the heat often causes a number of "worms" to crawl out and escape. A few growers throw "drop" peaches into a convenient body of water. This may answer the purpose if the stream or lake is large enough and not too shallow.

When this control measure was first advocated, some growers opposed it on the ground that the expense involved in picking up the peaches would be too great; after it was tried, however, the cost was found to be comparatively small. In Georgia during the season of 1921, when the price of labor was still high, it averaged about 1 cent

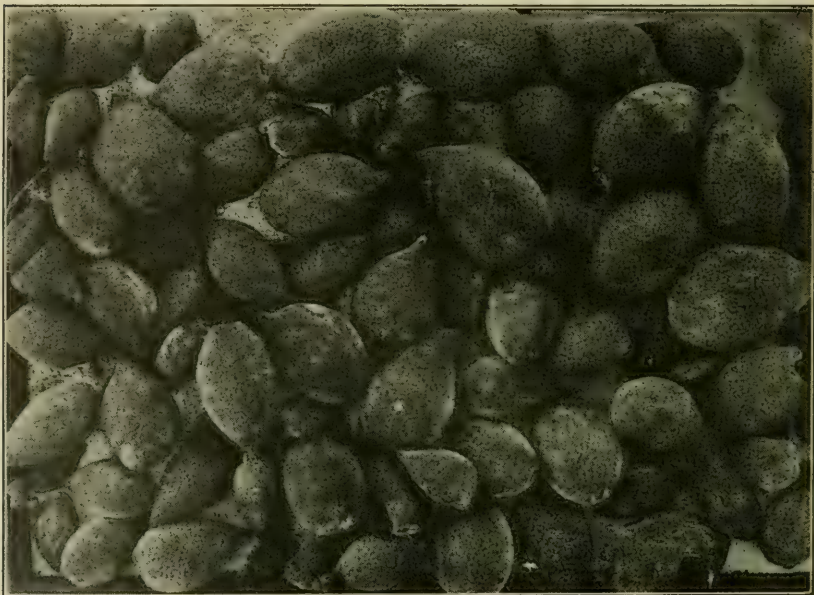


FIG. 8.—The larger "drops" are not so likely to be infested with curculio larvæ.

per tree for each gathering—a very cheap form of insurance, considering the results obtained.

This is probably the surest of all control measures for the curculio, since if the fruit has been picked up and destroyed as advised, the orchardist may be certain that the development of all curculios from the larvæ in fallen fruit has been prevented. In the Gulf States, where there is a partial second generation of the curculio annually, this practice is almost as important as spraying or dusting. It would be wise, therefore, for peach growers in the South to pick up all "drops" frequently and systematically making a special effort to get the smallest, hard, dried-up fruits, as these are the ones most likely to be infested. The picking up and destroying of drops also aids in the control of brown-rot, since the fungus causing this disease is able to

live in and fruit upon the old "mummies" which become sources of distribution for this destructive disease.

DISKING AS A CONTROL MEASURE.

After the larva or "worm" of the curculio has reached maturity in the peach, it eats its way out and enters the soil to pass the pupa stage, which is the period of transformation from the larva to the adult or beetle. The "worm," however, does not pass into the pupa stage immediately after entering the soil, but remains in the larva stage for a few days until it can prepare a soil cell to protect it during the transformation. Upon the completion of this cell, which is



FIG. 9.—Using the extension disk for destruction of curculio pupæ.

merely a small cavity in the soil smoothed by the larva, the "worm" changes to the pupa, the helpless, inactive stage in the insect's development. Frequent disking during this period with an extension disk (fig. 9), so that the soil can be stirred close to the tree trunks, destroys or breaks up many of the pupal cells, and since the insect is in a helpless state, another cell can not be prepared. The pressure and heat of the soil then cause the death of many pupæ, in addition to those killed directly by the disk or by exposure to the elements and predacious enemies.

The time spent in the soil by the curculio during this period of transformation averages about one month, and the pupal cells are mostly within 3 inches of the soil surface. Diskings for destruction

of pupæ should begin in the South about May 15 and be repeated frequently, at intervals of one week if practicable, until the late varieties have been harvested, provided the orchard is not sown down to peas or other crops in June or July. An effort should be made to disk as close to the tree trunks as possible without scarring them, as most of the pupal cells occur under the spread of the trees. Since pupæ in the soil during May and June develop into beetles that are responsible for most of the "worms" in late varieties at harvest time, this is a highly desirable control measure.



FIG. 10.—Jarring peach trees to catch the adult curculios.

JARRING FOR THE CURCULIO.

In sections where the curculio infestation is expected to be heavy it would probably be profitable to jar the trees in the spring, especially near woodlands or other hibernating places, to collect the beetles. (Figs. 10 and 11.) The beetles leave their hibernating quarters just before or at the time the trees are in full bloom. At this season of the year their number is much greater on the trees near the places where they have hibernated, as it takes some time for them to become disseminated over the whole orchard. When the beetles are disturbed they fold their legs and fall to the ground, or "play possum." They are less active during the early morning than at any other time, and the jarring can best be done before the sun is very high. During cloudy days, however, the operation can be conducted at any time of

the day. The jarring frames should be in pairs, each frame 12 by 6 feet in area, with a notch about 10 by 10 inches in the middle of the side of one frame to receive the tree trunk. Light strips should be used in their construction, as otherwise the frames will be too heavy to handle. A low grade of cotton sheeting can be used for the cover. The trees are jarred with a pole well padded on one end. Burlap covered with a piece of old automobile tire makes a very good pole padding.

Several dozen trees can be jarred early in the morning before it will be necessary to remove the beetles. After the sun is well up, the beetles become active and, although they will fall as soon as



FIG. 11.—Picking curculios off of jarring frames.

the tree is jarred, some will begin to crawl off immediately. The beetles can be easily killed by dropping them into a small bucket of kerosene. The frames can be carried by women or children, two to each frame. For each pair of frames five persons are required, four to carry the two frames and one to jar the trees. Growers will find this control measure more profitable at or near the blooming season, in sections of the orchard near hibernating places, than at other times or elsewhere.

DUSTING FOR THE CURCULIO AFTER HARVEST.

From the time the peaches are harvested until the leaves drop in the fall, the adult curculios are forced to derive a large part of their

food from peach foliage. To ascertain if it is possible to poison these beetles with arsenate of lead before they go into hibernating quarters so as to reduce the number of overwintering adults, after-harvest dusting experiments have been conducted for the last three years. Each year the results have been encouraging, but the data obtained during the season of 1921 were particularly interesting. In a period of 22 days, beginning four weeks after the fruit was harvested, the number of curculios increased 70 per cent on an untreated block of 500 trees, owing largely to the emergence of adults of the second generation. Adjoining the untreated block was a block of trees of similar size that had been dusted with 90 per cent hydrated lime and 10 per cent arsenate of lead about four weeks after fruit harvest. On the treated block there was a decrease of 13 per cent in the number of adult curculios caught in the same period of 22 days. While the decrease was not great, the chief benefit from the application of dust was in controlling second-generation adults, which were emerging in numbers during the time the work was under way, as shown by the increase in the number of beetles caught on the untreated block.

As an added protection to the succeeding peach crop, growers will probably find two after-harvest applications of 90 per cent hydrated lime and 10 per cent arsenate of lead profitable. Best results have been obtained by making one application about four weeks after the fruit has been harvested and another about two weeks later. Applications made earlier than four weeks after fruit harvest are not so effective, since feeding at that time is confined largely to the few fruits left on the trees and on the ground. The curculios much prefer fruit to foliage for food.

RESULTS OF SPRAYING AND DUSTING EXPERIMENTS.

To ascertain at what time the insecticide and fungicide are most effective against the curculio, brown-rot, and scab, and to continue the work of comparing the efficiency of the liquid spray and the dust, a very extensive experiment was conducted in the vicinity of Fort Valley, Ga., during the season of 1921. Two hundred and thirty-six thousand peaches were cut open to obtain the data on results. (Fig. 12.) The experiment was duplicated on two varieties, Hiley and Elberta, the two most popular varieties in Georgia. The Hiley experiments were conducted in the J. H. Baird orchard, and the Elberta experiments in the orchard of the Hale Georgia Orchard Co. These orchards were 3 or 4 miles apart, which was desirable in order to test the various spraying and dusting schedules against the pests in two different localities. Both orchards had suffered very

severely during the previous season from the curculio and brown-rot, and near them at a number of places were excellent hibernating quarters for the curculio.

Approximately 5,000 trees were utilized in the experiment, and they were divided into plats of as nearly 200 trees each as practicable, so that the various schedules would have equal chances to prove their effectiveness. An effort was also made to place all plats an equal distance from the hibernating quarters of the curculio. In the center of each plat 10 trees were selected and tagged as record trees. The fruit from these trees was harvested separately, and each peach was cut open, examined, and recorded so that the exact percentages of



FIG. 12.—Cutting peaches to determine results of spraying and dusting.

sound fruit and of fruit injured by the curculio, brown-rot, and scab could be ascertained. All drops were collected from these record trees throughout the season and examined for data on the curculio infestation and the presence of brown-rot and scab. The Hiley orchard used for this work was on Norfolk sandy-loam soil and the Elberta orchard on Orangeburg sandy loam. Most of the trees were healthy and had made good growth. The age of all the Hiley trees was 12 years. The age of the Elbertas varied from 4 to 10 years and this was unfortunate, as the schedules used on the 4-year-old Elbertas did not receive a fair test with the schedules used on the older trees.

Table 1 gives the schedules used on the various plats. The same schedules were used on both Hileys and Elbertas, with the exception of Plat XIII, which was used only on the Elbertas.

TABLE 1.—*Outline of peach spraying and dusting experiments, Fort Valley, Ga., 1921.*

Plat No.	Applications.					
	1. As petals fall.	2. Between falling of petals and calyces.	3. As shucks fall.	4. Two weeks after shucks have fallen.	5. About one month before ripening.	6. Seven to ten days before ripening.
I. Spray.....			A. L. L.....	A. L. S. B.....	S. B.....	A. L. S. B. T. P. S. B. D. A.
II. Spray.....			A. L. L.....	A. L. S. B.....	A. L. S. B.....	
III. Spray.....		A. L. L.....		A. L. S. B.....	S. B.....	
IV. Spray.....		A. L. L.....		A. L. S. B.....	A. L. S. B.....	
V. Spray.....		A. L. L.....	A. L. L.....	A. L. S. B.....	S. B.....	
VI. Spray.....		A. L. L.....		A. L. S. B.....	S. B.....	
VII. Spray.....		T. P. L.....		T. P. S. B.....	T. P. S. B.....	
VIII. Spray.....	T. P. L.....		T. P. L.....	T. P. S. B.....	S. B.....	
IX. Dust.....		D. A.....		D. A.....	D. A.....	
X. Dust.....			D. A.....	D. A.....	D. A.....	
XI. Dust.....			D. A. 10.....	D. A. 10.....	D. A. 10.....	
XII. Check.....						
XIII. Spray.....	A. L. L.....		A. L. L.....	A. L. S. B.....	S. B. (Elbertas only.)	

A. L. = Arsenate of lead powder, 1 pound to 50 gallons of spray.

L. = Lime water from 3 pounds of stone lime per 50 gallons of water.

S. B. = Self-boiled lime-sulphur mixture, 8-8-50.

T. P. = Triplobic arsenate paste, 2 pounds to 50 gallons of water.

D. A. = Dust arsenate of lead, 5 per cent; sulphur, 80 per cent; lime, 15 per cent.

D. A. 10 = Dust arsenate of lead, 10 per cent; sulphur, 80 per cent; lime, 10 per cent.

All dust applications were made with large power dusting machines, and the liquid was applied with power sprayers developing from 250 to 275 pounds pressure. In ascertaining the results at harvest, data were obtained on the commercial production of No. 1 and cull fruit from each plat in addition to the detailed data on the fruit from the record trees. These commercial data were obtained at the packing sheds, the Hileys being graded on a grading machine and the Elbertas graded by hand by experienced peach packers.

HILEY VARIETY.

Tables 2, 3, and 4 give the results in terms of percentages of the spraying and dusting experiments conducted on the Hiley variety. Table 2 gives the data obtained on the fruit cut open at harvest from the record trees in each plat. The last two columns on the right in this table give the percentages of No. 1 and cull fruit harvested from the record trees. These commercial data were obtained by grading the fruit before it was cut open for examination. Table 3 gives the percentage of curculio-wormy fruit in both the drops and harvested fruit from the record trees of each plat. Table 4 gives the percentages of merchantable and cull fruit from all the trees in each plat.

TABLE 2.—Summary of results from peach spraying and dusting experiments, Fort Valley, Ga., 1921; Hiley variety, harvested fruit.

Plat No.	Total number of fruits.	Per cent of total fruit—										
		Cur- culio- wormy.	Brown- rot.	Scab.	Cur- culio- wormy only.	Brown- rot only.	Cur- culio- wormy and brown- rot.	Brown- rot in- fection at cur- culio feeding puncture.	Brown- rot in- fection at cur- culio egg or larval puncture.	Sound.	No. 1 fruit.	Cull fruit.
I	5,152	15.16	1.85	0	14.73	0.06	-----	1.36	0.43	83.42	80.67	19.33
II	5,704	6.89	3.18	0	6.31	.11	-----	2.49	.58	90.51	83.82	16.18
III	3,973	23.74	4.35	0	21.95	.05	-----	2.51	1.79	73.70	81.00	19.00
IV	3,364	13.40	2.23	0	12.78	.03	-----	1.58	.62	84.99	84.71	15.29
V	4,687	14.13	.98	0	13.68	.02	-----	.51	.45	85.34	85.05	14.95
VI	4,672	14.85	2.12	0	14.19	-----	-----	1.46	.66	83.69	84.91	15.09
VII	5,214	12.41	2.50	0	11.68	.02	0.02	1.75	.71	85.82	77.66	22.34
VIII	2,529	29.02	6.69	0	26.33	.24	.04	3.76	2.65	66.98	72.86	27.14
IX	3,044	11.56	2.14	0	11.10	-----	-----	1.68	.46	86.76	82.35	17.65
X	4,037	18.13	2.92	0	17.24	.05	-----	1.98	.89	79.84	87.82	12.18
XI	3,370	20.47	4.13	0	19.37	.09	-----	2.94	1.10	76.50	82.72	17.28
XII	3,000	40.79	4.87	0	37.97	.17	-----	2.20	2.50	57.16	64.38	35.62

TABLE 3.—Percentage of total fruit curculio-wormy, Hiley variety, both "drops" and harvested fruit, peach spraying and dusting experiments, Fort Valley, Ga., 1921.

Plat No.	Total number of fruits examined.	Total per cent curculio-wormy.	Plat No.	Total number of fruits examined.	Total per cent curculio-wormy.
I	9,854	22.76	VII	9,691	18.63
II	11,893	25.15	VIII	6,773	47.62
III	7,863	24.48	IX	6,876	26.28
IV	6,730	17.04	X	8,310	26.22
V	8,561	13.23	XI	7,000	26.19
VI	8,202	15.19	XII	9,893	54.14

TABLE 4.—Commercial results of fruit from all trees in each plat, Hiley variety, peach spraying and dusting experiments, Fort Valley, Ga., 1921.

Plat No.	Per cent No. 1 fruit.	Per cent cull fruit.	Plat No.	Per cent No. 1 fruit.	Per cent cull fruit.
I	85.42	14.58	VII	81.39	18.61
II	86.16	13.84	VIII	74.71	25.29
III	84.82	15.18	IX	84.41	15.59
IV	83.66	11.34	X	87.92	12.08
V	87.00	13.00	XI	85.63	14.37
VI	86.34	13.66	XII	69.54	30.46

There was no scab in the orchard of the Hiley variety, and very little brown rot developed, so that no data of value were obtained on the control of these diseases in this orchard. The weather was dry and unfavorable for the development of fungous diseases during the season of development of this variety.

Some interesting and valuable information on curculio control was obtained in this orchard, however. To ascertain the effect of early spraying for the curculio, both "drops" and harvested fruit must be examined, as the early applications of arsenate of lead are directed especially against curculio injury to the small peaches. It is important to reduce the curculio infestation in small peaches as much as possible in order that the second generation may not be large.

Table 3, which gives the data from examinations of both the "drops" and harvested fruit, shows that the percentage of curculio-wormy fruit was lowest on Plat V. This plat received three applications of lead arsenate before the fruit entered the stone-hardening period, the first of which was applied as the shucks were splitting, or between the falling of the petals and shucks. Plats VI, IV, and VII, which gave, in the order named, the next lowest percentages of curculio-wormy fruit, all received the first treatment of arsenate of lead between the falling of the petals and shucks. On the block receiving no treatment throughout the season, Plat XII, over one-half of the "drops" and harvested fruit was wormy, whereas Plat V, one of the sprayed plats, had only 13.23 per cent wormy fruit. Those who are inclined to doubt the value of spraying should be convinced by these figures.

The value of an application of arsenate of lead about four weeks before the fruit is due to ripen, for the control of the second generation of the curculio, is shown in Table 2, which contains the data on the harvested fruit alone. Plat II received the same treatment as Plat I, except that arsenate of lead was used in the last application on Plat II and omitted on Plat I. At harvest Plat II gave only 6.89 per cent wormy fruit, whereas Plat I had 15.16 per cent wormy fruit, or more than twice as much. Likewise, the treatments used on Plats III and IV were the same, except that Plat IV received arsenate of lead in the treatment about a month before harvest and Plat III did not. At harvest Plat IV gave only 13.40 per cent curculio-wormy fruit, whereas Plat III had 23.74 per cent wormy, or almost twice as much. In Table 2 the value of spraying is again shown by 40.79 per cent wormy fruit at harvest on the plat (No. XII) which received no treatment as compared with 6.89 per cent wormy fruit on Plat II, one of the treated plats.

From the data in Tables 2 and 3 it would appear that the liquid-spray applications controlled the curculio somewhat better than the dust applications. No data are available from the work on the Hiley variety during the season of 1921 that would indicate which method is most effective in controlling brown-rot and scab. It has been the consensus of opinion among many who have tested the two methods in the past that there is little difference between them in controlling brown-rot and scab, but that the liquid seems to control the

curculio a little more satisfactorily than the dust. The dusting method has its good points, such as quickness of application, etc., but it is not the purpose of this bulletin to discuss at length the relative efficiency of the two methods. Plat X, treated with a dust formula containing 5 per cent arsenate of lead, gave practically as good curculio control as Plat XI, a plat dusted at the same times as Plat X but with a dust formula containing 10 per cent of arsenate of lead. Plat IX, receiving one more application of dust than the other dusted plats, the first treatment being given earlier, produced less wormy fruit than the other dusted plats. Results showing that 5 per cent arsenate of lead in a dust mixture would give practically as good control of the curculio as 10 per cent, in dusting experiments conducted by the senior author during previous years, are in accord with the findings in 1921 as noted above.

Table 4 shows that Plat IV, which received both the early and late spray applications of arsenate of lead, gave the highest percentage of commercial No. 1 fruit. The commercial grading, as before stated, was done by the grading machine, and the fruit from some plats was not closely graded. Very often fruit containing curculio injury was allowed to go through to the packers.

ELBERTA VARIETY.

Tables 5, 6, and 7 give, in percentages, the results of the spraying and dusting experiments conducted on the Elberta variety. Table 5 gives the data on the fruit at harvest from the record trees, Table 6 gives the percentages of wormy fruit for both "drops" and harvested fruit from the record trees, and Table 7 gives the commercial results from each plat as a whole.

TABLE 5.—Summary of results of peach dusting and spraying experiments, Fort Valley, Ga., 1921; Elberta variety, harvested fruit.

Plat No.	Total number of fruits.	Per cent of total fruit.								
		Curculio-wormy.	Brown-rot.	Scab.	Curculio-wormy only.	Brown-rot only.	Scab only.	Curculio-wormy.		
								Brown-rot, scab.	Brown-rot.	Scab.
I	4,997	41.51	31.65	1.32	29.19	5.82	0.46	0.04	0.24	0.54
II	4,729	28.27	35.93	3.44	17.45	8.50	1.69	.02	.59	.82
III	9,763	39.59	32.48	1.24	26.84	7.01	.47	.03	.33	.38
IV	9,083	29.67	19.81	1.78	22.50	4.98	.97	.01	.14	.38
V	6,575	48.75	18.49	2.03	38.92	3.01	.73	.00	.21	1.04
VI	5,685	47.44	20.94	.62	37.73	2.73	.28	.02	.30	.19
VII	5,737	37.43	48.68	1.07	19.92	6.99	.35	.02	.26	.30
VIII	6,953	50.16	18.34	.97	41.51	3.60	.33	.03	.32	.43
IX	1,838	53.00	46.19	.86	31.67	7.35	.27	.00	1.04	.27
X	1,878	54.95	55.81	2.24	26.62	7.61	.69	.00	1.33	.64
XI	1,988	55.23	35.80	3.42	35.97	4.98	.86	.20	1.41	1.46
XII	4,844	45.42	77.81	45.56	4.40	4.67	9.10	.49	.33	4.71
XIII	9,667	39.56	12.78	.55	33.94	2.69	.32	.02	.24	.14

TABLE 5.—Summary of results of peach dusting, etc.—Continued.

	Per cent of total fruit.							
Plat No.	Brown-rot, scab.	Brown-rot infection at curculio, egg, or larval puncture.	Brown-rot infection at curculio feeding puncture.	Brown-rot at curculio, egg, or larval puncture with scab.	Brown-rot at curculio feeding puncture with scab.	Sound.	No. 1 fruit.	Cull fruit.
I	0.08	11.40	13.87	0.10	0.10	38.16	61.31	38.69
II	.42	9.20	16.71	.19	.30	44.11	64.94	35.06
III	.12	11.86	12.89	.15	.09	39.83	60.20	39.80
IV	.10	6.44	7.82	.20	.12	56.34	76.08	23.92
V	.09	8.50	6.51	.08	.09	40.82	69.20	30.80
VI	.04	9.18	8.58	.02	.07	40.86	66.33	33.67
VII	.05	16.68	24.33	.25	.10	30.75	47.15	52.85
VIII	.03	7.81	6.40	.06	.09	39.39	68.33	31.67
IX	.05	19.91	17.57	.11	.16	21.60	43.48	56.52
X	.27	26.04	19.92	.32	.32	16.24	39.24	60.76
XI	.05	15.69	12.62	.50	.35	25.91	58.54	41.46
XII	4.42	22.36	18.70	13.13	13.71	3.98	17.88	82.12
XIII	.01	5.21	4.55	.01	.05	52.82	77.23	22.77

Trees in Plats I, II, IV, V, VI, VII, VIII, and XII, 8 years old.

Trees in Plats III and XIII, 10 years old.

Trees in Plats IX, X, and XI, 4 years old.

TABLE 6.—Percentage of total fruit curculio-wormy, *Elberta* variety, both "drops" and harvested fruit, peach spraying and dusting experiments, Fort Valley, Ga., 1921.

Plat No.	Total number of fruits examined.	Total per cent curculio-wormy.	Plat No.	Total number of fruits examined.	Total per cent curculio-wormy.
I	10,828	51.14	VIII	11,871	49.81
II	10,672	49.01	IX	3,635	56.23
III	15,845	37.64	X	3,389	57.63
IV	13,902	33.04	XI	3,247	56.23
V	11,004	44.59	XII	12,433	62.32
VI	10,128	48.05	XIII	14,583	32.95
VII	12,665	48.85			

TABLE 7.—Commercial results of fruit from all trees in each plat, *Elberta* variety, peach spraying and dusting experiments, Fort Valley, Ga., 1921.

Plat No.	Per cent No. 1 fruit.	Per cent cull fruit.	Plat No.	Per cent No. 1 fruit.	Per cent cull fruit.
I	64.26	35.74	VIII	65.00	35.00
II	70.24	29.76	IX	53.45	46.55
III	67.67	32.33	X	48.52	51.48
IV	77.65	22.35	XI	59.67	40.33
V	71.98	28.02	XII	26.09	73.91
VI	68.64	31.36	XIII	77.33	22.67
VII	57.86	42.14			

All of the spraying and dusting schedules had a very much more severe test on the *Elbertas* than on the *Hileys*. A strip of woodland adjoined the experimental plats along their entire eastern boundary, and this woodland had hibernated myriads of curculio beetles during the previous winter. Furthermore, brown-rot had been very severe

in this orchard in years past, and the overstimulation of the trees by nitrogen on strong soil, in addition to the very thick tree centers, was particularly conducive to the development of the disease in 1921.

Frequent rains occurred just before and during the Elberta season, and this also assisted in the development of brown-rot, which was very severe in the Elberta experimental orchard. Seventy-eight per cent of the fruit harvested from the plat receiving no treatments throughout the season was infected with brown-rot. The severity of the test to which the schedules were put can be realized from the amount of sound fruit harvested from the block receiving no treatments, as shown in Table 5. This plat (XII) produced only 3.98 per cent of sound fruit during harvest, the remaining 96.02 per cent being damaged by curculio, brown-rot, or scab.

Referring to Table 6, it will be seen again that the plats that received the early applications of arsenate of lead produced less curculio-wormy "drops" and harvested fruit. Plat XIII, which received the earliest arsenical application of all, gave the lowest percentage of curculio-wormy "drops" and matured fruit.

The four applications of triplumbic arsenate used on Plat VIII did not control the curculio as well as three applications of the standard or diplumbic arsenate. Triplumbic arsenate, which is a slow-killing poison, was used on Plats VII and VIII to see if a greater number of applications would give better curculio control without serious arsenical burning of the foliage.

The value of a late application of arsenate of lead for the control of the second generation of the curculio is demonstrated again in the work on Elbertas. Table 5, which gives the results of harvested fruit, shows that Plat I gave over 13 per cent more curculio-wormy fruit than Plat II. Plat II received arsenate of lead in the treatment a month before harvest, whereas it was omitted in the last treatment on Plat I; otherwise the treatments on the two plats were similar. The spray schedules used on Plats III and IV were the same, except that Plat IV received the late application of arsenate of lead and Plat III did not. Consequently Plat III gave 10 per cent more wormy fruit than Plat IV. The value of spraying is clearly demonstrated by comparing the data of Plats XII and XIII of Table 5. Spraying increased the percentage of harvested sound fruit 49 per cent on Plat XIII as compared with Plat XII, which partly joined Plat XIII and received no treatment throughout the season.

In interpreting the results of this work the efficiency of the late applications of arsenate of lead can be measured only from tables giving results of harvested fruit, as practically all "drops" had fallen before this application was made. In securing information on the results from early arsenical treatments the tables giving data on both "drops" and harvested fruit must be consulted, as the early

arsenical treatments are applied especially for the control of the curculio in "drops."

The curculio control on all treated Elberta plats can not be called excellent, but in interpreting the results one must first consider the very severe test to which all treatments were put.

The two applications of self-boiled lime-sulphur applied two weeks after the shedding of the calyces or shucks, and about one month before the fruit ripened, gave good control of brown-rot, considering the severity of the test. Seventy-eight per cent of the fruit harvested from the blocks of Elbertas receiving no treatment throughout the season was infected with brown-rot. The fruit infected with brown-rot harvested from the plats receiving two applications of self-boiled lime-sulphur averaged 25 per cent, or there was a reduction of 53 per cent of brown-rot infection by the use of the two self-boiled lime-sulphur treatments. There was only 13 per cent of brown-rot on one of the plats receiving the two fungicide applications.

The two self-boiled lime-sulphur treatments controlled scab remarkably well. Forty-six per cent of the fruit harvested from the untreated blocks was scabby, whereas less than 2 per cent of the fruit from the plats receiving the fungicide was infected with scab. The scab on some of the treated plats was negligible, Plats VI and XIII having only about one-half of 1 per cent.

The results from Plats IX, X, and XI, which are the dusted plats, can not be used for comparison with the liquid-sprayed plats in measuring the efficiency of the two methods of pest control, since the trees in these three plats were four years younger than the rest and the crop was exceedingly light. The number of fruits per tree was very much less on these plats, and consequently the curculio injury would run much higher as compared with older trees in the same orchard, bearing a heavy crop.

Table 7 shows that Plats IV and XIII gave the highest percentage of commercial No. 1 fruit. Plat IV received an early and a late application of arsenate of lead. Plat XIII received an extra early arsenate-of-lead treatment. Plat XII, the untreated block, produced only 26 per cent commercial No. 1 fruit, which is over 50 per cent less than the No. 1 fruit produced on Plats IV and XIII.

DUSTING AND SPRAYING RECOMMENDATIONS.

Feeding tests show that it usually takes from four to seven days to kill the adult curculio with peach leaves sprayed or dusted with arsenate of lead. Since the beetles are on the trees in numbers at the blooming season and since observations show considerable feeding on the calyces, or "shucks," before the fruit is exposed or before the

"shuck" is split, an application of arsenate of lead immediately after the falling of the petals would be very desirable for reducing the number of beetles to deposit eggs in the fruit after it is exposed. Furthermore, the results of the spraying and dusting experiments of 1921 discussed in this circular show conclusively that the curculio was much better controlled on all plats that received an early application of arsenate of lead.

Field observations and laboratory studies conducted during the past seasons confirm former studies in that there is little curculio activity during the stone-hardening period of the peach, which begins from three to four weeks after the shucks have fallen and ends about a month before the fruit ripens. Applications of arsenate of lead during this period are therefore of little value.

In order to control the second generation of the curculio, an application of arsenate of lead should be made about four weeks before the fruit is due to ripen. The results of experiments previously discussed show the value of lead arsenate at that time for the control of the second generation of curculio larvæ.

SPRAYING SCHEDULE.

As a result of studies and experiments conducted during the 1921 season at Fort Valley, Ga., and elsewhere in the South during previous years, the following spraying and dusting schedules for peaches are recommended for future use in Georgia and the Gulf States for the control of the curculio, brown-rot, and scab.

First application.—Immediately after the petals (pink part of flower) have fallen, use 1 pound of powdered arsenate of lead, plus lime water from 3 pounds of unslaked lime, to each 50 gallons of water.

Second application.—When calyces, or "shucks," are shedding, which is usually about 10 days after the falling of the petals, use the same spray as for the first application.

Third application.—Two weeks after the second application, or about four weeks after the petals have been shed, use 1 pound of powdered arsenate of lead with each 50 gallons of 8-8-50 self-boiled lime-sulphur.

Fourth application.—About four weeks before each variety is due to ripen, use the same spray as recommended for the third application.

DUSTING SCHEDULE.

If the grower desires to use dust instead of liquid, the 80 per cent sulphur, 5 per cent arsenate of lead, and 15 per cent hydrated lime formula is recommended for all applications. Four applications in all should be given as follows: First, immediately after the petals

have fallen; second, when the calyces, or "shucks," are shedding, or about 10 days after the first dusting; third, two weeks after the second application; fourth, about four weeks before each variety is due to ripen.

DIRECTIONS FOR PREPARING SPRAY MATERIALS.

The 8-8-50 self-boiled lime-sulphur called for in the spraying schedule is made as follows:

Place 8 pounds of unslaked or stone lime in a 50-gallon barrel, and pour over it enough water, preferably warm, to start the slaking. As the slaking begins, add 8 pounds of sulphur. Add water from time to

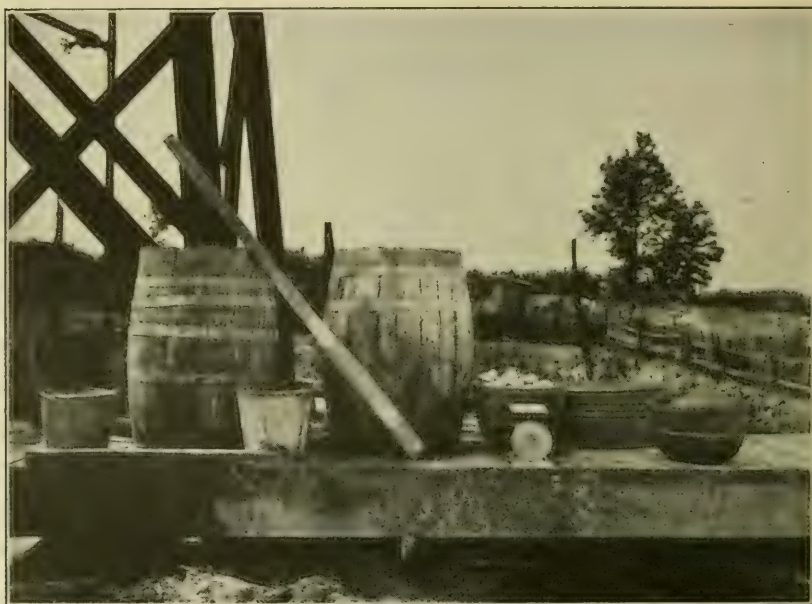


FIG. 13.—Articles necessary for preparing self-boiled lime-sulphur. Note handy arrangement for water.

time to keep the mixture from becoming dry, but be careful not to drown the lime, as this will cause the boiling process to stop too soon. After the mixture has boiled about five minutes, or when the lime has about finished slaking, cool with water, strain into the spray tank, and dilute to 50 gallons. Care should be taken to cool the mixture by the addition of water before the red streaks begin to appear in it to any extent, as the red liquid is likely to be injurious to peach foliage. Better results will be obtained by crushing all lumps of sulphur and mixing it with a little water before adding it to the slaking lime. (Figs. 13 and 14.)

The formula may be raised to 16-16-100 or 32-32-200. A large container should be used, however, in preparing self-boiled lime-

sulphur with these formulas. Stock solutions can, of course, be made up, the proportions given being observed.

The powdered arsenate of lead which is used in the proportion of 1 pound to 50 gallons of the spray solution should first be made into a thin paste with water before addition to the spray tank.

Materials for dusting should be very fine and thoroughly mixed. A very light diplumbic arsenate, superfine sulphur guaranteed 95 per cent to pass a 200-mesh sieve, and hydrated lime should be used for all dust mixtures.



FIG. 14.—Preparation of self-boiled lime-sulphur is an easy and simple operation with the proper equipment.

SUCCESS WITH SPRAYING OR DUSTING DEPENDS ON THOROUGHNESS.

To attain successful pest control with either spray or dust, the applications must be made at the right time with thoroughness. (Fig. 15.) The failure of many peach growers to secure the proper control of insects and diseases very often is directly due to careless spraying by inexperienced or unsupervised laborers, whose object is to get over the greatest number of trees in a given time, with no attention to how well the job is done. When spraying, work on each tree should be completed by the spray man before he goes to the next. It is best to start on the side of the tree opposite the spray outfit and work around it until the entire tree is covered. An effort should be made

to cover all sides of each peach. This system takes the spray outfit down every other middle. Very often a portion of the tree is completely missed by the spray when only one-half of the trees are sprayed from one middle and finished when the outfit comes up the next middle.

It is quite essential, when using dust, to proceed down each tree row, dusting the near side of every tree. (Fig. 16.) It is practically impossible to obtain satisfactory results if dusting is done only in every second or third tree row. It is best to make each dust application from a different side of the tree, but usually the prevailing wind makes this impossible. Avoid wasting the material. If the wind is blowing in the same direction that the duster is moving,



FIG. 15.—Thoroughness is the keynote of successful spraying.

open the discharge pipe before reaching the tree and close it before the tree is passed. If the wind is blowing in the opposite direction from the way the duster is moving, then a better job of dusting can be accomplished by waiting until the outfit is opposite the tree before opening the discharge pipe. Always move the discharge pipe in one direction, either horizontally or vertically, until the tree is enveloped in the dust.

As mentioned before, the severe curculio infestation of 1920 in Georgia was due very largely to exceedingly careless spraying, with no attention as to when the applications were made. *The curculio, brown-rot, and scab must be controlled at very definite times, and*

spraying and dusting at other times will not bring the desired results. It is universally conceded by those connected with the peach industry in Georgia that the thorough spraying and dusting, the applications of which were made at the time when they would be most effective, was the potent factor in the successful control of the curculio and brown-rot in the 1921 crop. If the water supply is far distant from the orchard or if there are not sufficient spray outfits to handle the acreage in a few days, much time can be saved by hauling the water to the spray outfits in the orchard (fig. 17). If this is done, the spray tank can be refilled at any place in the orchard when the spray gives out. Where the spraying job is left almost en-

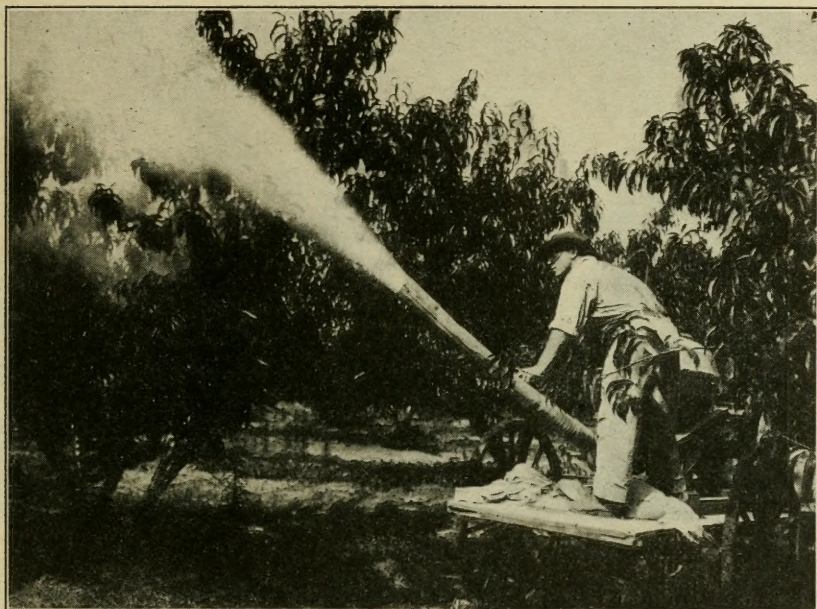


FIG. 16.—It is necessary to proceed down each tree row, dusting each tree from one side.

tirely to laborers, as is the case in most sections of the Georgia peach belt, proper supervision should be maintained at all times to see that the operation is thoroughly performed. The importance of making the spray applications to future peach crops at exactly the right time, with special attention to thoroughness, can not be too strongly emphasized.

CURCULIO AND BROWN-ROT CONTROL MEASURES MUST BE MADE ANNUAL ORCHARD PRACTICES.

Peach culture has been practiced so long in Georgia and the acreage has grown to be so extensive that the curculio, brown-rot, and other peach pests have established themselves in practically all sec-

tions of the State. In order to save future Georgia peach crops from the curculio, as well as from brown-rot and scab, the control measures discussed in this circular should be made annual orchard operations with every peach grower. Each winter special attention should be given to orchard sanitation, the fence and terrace rows cleaned up, brush and pruning piles destroyed by burning, and adjoining woodlands and waste lands burned over. Too much emphasis can not be placed upon the importance of picking up all dropped peaches from shortly after the blooming season until the fruit is harvested. About May 15 disking for destruction of curculio pupæ should be started,



FIG. 17.—Hauling water to the spray outfit in the orchard saves time.

and continued as frequently as possible thereafter until harvest. The spraying or dusting schedule as outlined in this circular should above all be closely followed at the exact time indicated and with the utmost thoroughness.

If this program of work is put into practice in its entirety with care, future peach crops in Georgia can be saved from pests, regardless of weather conditions. Should growers again become careless with these control measures, another crop failure can be expected, as previous serious peach-pest seasons have left the Georgia peach belt with many sources of brown-rot infection and countless numbers of adult curculios.

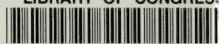
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